Remarks

Applicant respectfully requests favorable reconsideration of this response and amendment, as well as consideration of the pending claims as amended herein. The Examiner is encouraged to contact the undersigned by telephone to facilitate any remaining questions or issues.

Status of Pending Claims:

Claims 216-220, 222-229, 231-232, 235, 237-253, 258-260, 342 and 350 are pending in this application.

There are no claims which are (Currently amended).

Claims 216, 218-219, 222-224, 227-229, 231-232, 235, 237-244, 247-250, 252-253, 258-260, 342 and 350 are (Previously presented).

Claims 217, 220, 225-226, 238, 245-246 and 251 are (Original).

There are no claims which are (New).

Claims 1-215, 221, 230, 233-234, 236, 254-257 are (Canceled).

Claims 261-341 and 343-349 are (Withdrawn).

Amendments to the Claims:

There are no claim amendments in this office action response.

Summary of Examiner's Claim Rejections:

Claims 216-220, 222, 223, 224, 328-240, 243, 248-253, 258, 342, are rejected under 35 U.S.C. 103(a) as being unpatentable over US 4841731 (Tindell) in view of U.S. 5388395 (Scharpf et al.). Claims 216-220, 222, 224, 228-229, 238-240, 243, 248-254, 256, 258, 342, are rejected under 35 U.S.C. 103(a) as being unpatentable over US 3459953 (Hughes et al) in view of Scharpf et al. Claims 225-227 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 5899072 (Gode). Claims 231, 235 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 5516359 (Kang et al). Claim 237 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 4440545 (Weidig). Claim 241 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 3975913 (Erickson). Claim 242 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and US 2406605 (Hurd et al). Claims 244-247 are rejected under 35 U.S.C. §

103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 6698183 (Thordarson). Claim 242 is rejected under 35 U.S.C. § 103(a) as being unpatentable over (Tindell) in view of U.S. 2406605 (Hurd et al.). Claims 259, 260 and 350 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf et al. and U.S. 6212876 (Gregory et al.).

Marked-up Set of Claims (According to 37 CFR 1.121(c))

Claims 1 – 215 (Canceled)

216. (Previously presented) An engine comprising a combustion camber, wherein a mixture of oxygen, as O_2, and hydrogen, as H_2, are combusted, wherein

at least a portion of said oxygen is obtained by the separation of air, wherein

said separation of air is selected from the group consisting of: (a) cryogenic air separation, (b) membrane separation, and (c) pressure swing adsorption air separation and any combination thereof, wherein

at least a portion of the energy of combustion powers at least a portion of said air separation, and wherein

the temperature of combustion is at least partially controlled with the addition of water to said combustion chamber in a way that maintains combustion or combustion exhaust temperature.

217. (Original) The engine of claim 216, wherein mechanical rotating energy is created.

218. (Previously Presented) The engine of claim 217, wherein said rotating mechanical energy turns a generator to create electrical energy.

219. (Previously Presented) The engine of claim 216, wherein the steam produced by combustion turns a steam turbine, and wherein

said steam turbine turns a generator to create electrical energy.

220. (Original) The engine of claim 216, wherein heat is created.

221. (Canceled)

222. (Previously presented) The engine of claim 218 or 219, wherein at least a portion of said electrical energy is used in the electrolysis of water to hydrogen and oxygen, and wherein

at least a portion of at least one of said hydrogen and oxygen is used in said mixture.

223. (Previously presented) The engine of claim 216, further comprising nitrogen or

argon in said mixture.

224. (Previously presented) The engine of claim 216, wherein said oxygen further comprises air.

225. (Original) The engine of claim 216, wherein at least a portion of the steam produced by combustion is converted to hydrogen by the corrosion of at least one metal.

226. (Original) The engine of claim 225, wherein the conversion of said steam into said hydrogen is increased by an electrical current in said metal(s).

227. (Previously presented) The engine of claim 225 or 226, wherein said hydrogen is at least partially used in said mixture.

228. (Previously presented) The engine of claim 216, wherein a generator turns due to the movement of air or water, and wherein

said generator creates electrical energy, and wherein

said electrical energy is at least partially utilized in the electrolysis of water to hydrogen and oxygen, and wherein

at least a portion of at least one of said hydrogen and oxygen is used in said mixture.

229. (Previously presented) The engine of claim 216, wherein a photovoltaic cell creates electrical energy, wherein

said electrical energy is at least partially used in the electrolysis of water to hydrogen and oxygen, and wherein

at least a portion of at least one of said hydrogen and oxygen is used in said mixture.

230. (Canceled)

231. (Previously presented) The engine of claim 216, wherein at least a portion of the nitrogen separated from air in said cryogenic air separation unit is used to cool any portion of at least one selected from a list consisting of: said cryogenic air separation unit, the storage of oxygen, the storage of hydrogen, electrolysis, coolant for said engine, said engine and any combination thereof.

232. (Previously presented) The engine of claim 231, wherein said nitrogen separated from air in said cryogenic air separation unit is at least partially used to cool air or water.

223 – 234. (Canceled)

235. (Previously presented) The engine of claim 216, wherein said oxygen separated from air is at least one of enriched oxygen, pure oxygen and very pure oxygen.

236. (Canceled)

237. (Previously Presented) The engine of claim 216, wherein at least one selected from a list consisting of a: corrosion inhibitor, chelant, dispersant and any combination therein is added to at least a portion of the water in said engine.

238. (Original) The engine of claim 216, wherein said engine performs at least one of: internal, turbine and heating combustion.

239. (Previously Presented) The engine of claim 216, wherein at least one of oxygen and hydrogen is stored in at least one of a cooled gas state and a liquid state by liquefaction.

240. (Previously Presented) The engine of claim 239, wherein compressor(s) for at least one of cooling and liquefaction is powered by at least one of said engine and a fuel cell.

241. (Previously Presented) The engine of claim 240, wherein said fuel cell is powered by hydrogen and at least one of oxygen and air.

242. (Previously Presented) The engine of claim 216, wherein at least one of said hydrogen and oxygen is stored in a mixture with frozen water crystals to form a gel.

243. (Previously presented) The engine of claim 216, wherein at least one selected from a list consisting of: hydrogen, oxygen and water is preheated prior to combustion with the energy from at least one selected from a list consisting of: ambient temperature, said engine, said engine exhaust, an electrical radiant heat source and any combination therein.

244. (Previously Presented) The engine of claim 217, wherein said mechanical rotating energy from said engine enters a transmission, wherein

said transmission engage in a manner that is inversely proportional to at least one of the torque and work output of said engine, and wherein

said transmission output mechanical rotating energy turn a generator to create electrical energy.

245. (Original) The engine of claim 244, wherein said transmission engage a flywheel capable of storing rotational kinetic energy, wherein

said flywheel turns said generator.

246. (Original) The engine of claim 244, wherein at least a portion of said electrical energy is used in the electrolysis of water to hydrogen and oxygen.

247. (Previously presented) The engine of claim 246, wherein at least a portion of at least one of said hydrogen and oxygen is used in said mixture.

248. (Previously Presented) The engine of claim 216 or 219, wherein a pressure control device is in said engine exhaust.

249. (Previously Presented) The engine of claim 216, wherein at least one of said engine combustion heat energy and said engine exhaust energy is used to heat at least one of a gas and a liquid.

250. (Previously Presented) The engine of claim 249, wherein at least one of the gas is air and the liquid is water.

251. (Original) The engine of claim 250, wherein said exhaust discharge directly into said air or water.

252. (Previously presented) The engine of claim 216, wherein at least a portion of said engine is insulated.

253. (Previously presented) The engine of claim 216, wherein hydrogen is separated

from at least one selected from a list consisting of: water, air, nitrogen, oxygen and any combination thereof within said air separation unit.

254 – 257. (Canceled)

258. (Previously presented) The engine of claim 216, wherein the temperature of said engine exhaust is at least partially cooled with the addition of water to said engine exhaust.

259. (Previously presented) The engine of claim 258, comprising jet propulsion.

260. (Previously presented) The engine of claim 216 or 258, comprising rocket propulsion.

Claims 261 - 341 (Withdrawn)

342. (Previously presented) The engine of claim 216, wherein said engine comprises a turbine.

Claims 343 - 349 (Withdrawn)

350. (Previously presented) The engine of claim 256, comprising jet propulsion wherein said air is stoichiometrically increased in the jet intake for hydrogen thermodynamics and/or to operate with excess air for cooling.

Examiner Statements, Objections and Rejections

Examiner Statement

The newly added limitation in claim 216 "air separation unit with the energy powers at least a portion of the air separation" is taught in US 5388395 (Scharpf et al). Scharpf et al discloses an air separation unit 80 being powered partly by the steam (column 4, lines 20-22), which is a part of the combustion power. Therefore, a 103 rejection has been made to rejection claim 216 instead of the 102 rejections in the previous Office Action.

Applicant's Response

Applicant respectfully presents to the Examiner that Scharpf et al. does not teach the claim limitations presented in independent claim 216. The Examiner refers to column 4, lines 20-22 of Scharpf, wherein Scharpf states:

20 **where in the process. For example, some of the steam can be used to regenerate the thermal swing adsorbers in air separation unit 80. A warm exhaust gas is vented,**

Applicant would like to respectfully present to the Examiner that "to regenerate" is not the same teaching as "to power". It is a common practice in many industrial applications to regenerate an adsorption bed with steam, while such is not a "powering" of the adsorption process. Referring to Webster's, "regenerate" is defined as:

> [1]**regenerate 1** : formed or created again;...**3** : restored to a better, or more worthy state.

And, "power" is defined as:

> [1]**power 1** : **a** possession of control, authority or influence over others; ...6a : a source or means of supplying energy : esp. ELECTRICITY; **b** : MOTIVE POWER; c : the time rate at which work is done or energy emitted or transferred; ...
>
> **syn** POWER, FORCE, ENRGY, STRENGHT, MIGHT means the ability to exert effort, power may imply latent, external physical, mental or spiritual ability to act or be acted upon, FORCE implies the actual effective exercise of power, ENERGY applies to power expended or capable of being transformed into work, STRENGTH applies to the property

Examiner Statements, Objections and Rejections

Examiner Statement

The newly added limitation in claim 216 "air separation unit with the energy powers at least a portion of the air separation" is taught in US 5388395 (Scharpf et al). Scharpf et al discloses an air separation unit 80 being powered partly by the steam (column 4, lines 20-22), which is a part of the combustion power. Therefore, a 103 rejection has been made to rejection claim 216 instead of the 102 rejections in the previous Office Action.

Applicant's Response

Applicant respectfully presents to the Examiner that Scharpf et al. does not teach the claim limitations presented in independent claim 216. The Examiner refers to column 4, lines 20-22 of Scharpf, wherein Scharpf states:

20 **where in the process. For example, some of the steam can be used to regenerate the thermal swing adsorbers in air separation unit 80. A warm exhaust gas is vented,**

Applicant would like to respectfully present to the Examiner that "to regenerate" is not the same teaching as "to power". It is a common practice in many industrial applications to regenerate an adsorption bed with steam, while such is not a "powering" of the adsorption process. Referring to Webster's, "regenerate" is defined as:

> [1]**regenerate** **1** : formed or created again;...**3** : restored to a better, or more worthy state.

And, "power" is defined as:

> [1]**power** **1** : ...**6 a** : a source or means of supplying energy : esp. ELECTRICITY; **b** : MOTIVE POWER; **c** : the time rate at which work is done or energy emitted or transferred; ...
>
> **syn** POWER, FORCE, ENRGY, STRENGHT, MIGHT means the ability to exert effort, power may imply latent, external physical, mental or spiritual ability to act or be acted upon, FORCE implies the actual effective exercise of power, ENERGY applies to power expended or capable of being transformed into work, STRENGTH applies to the property

of a person or thing that makes possible the extension of force or the withstanding of strain, pressure or attack; MIGHT implies great or overwhelming power or strength.

In addition, Applicant would like to present to the Examiner that Scharpf et al. does not enable, teach or suggest the combustion of hydrogen, as is taught in the instant invention. To emphasis this point, Applicant would like to refer the Examiner to the same paragraph from which the Examiner refers, specifically col. 4 lines 10 – 20, which state:

> **Both the hot exhaust gas stream, in line 42, and steam from coal gasifier 70, in line 74, are fed to heat recovery steam generator 50. It is important to note that although the embodiments of the present invention are being described with reference to use of coal gasifier 70, this gasifier could be one which processes any carbonaceous feedstock. The purpose of the heat recovery steam generator is to recover heat from the hot exhaust gas stream and the steam from the coal gasifier, to produce electricity and appropriate level steam for use elsewhere in the process. For example, some of the steam**

(Emphasis added)

Therefore, while Scharpf et al. does not enable, teach or suggest "[a]t least a portion of the energy of combustion powers at least a portion of said air separation" as claimed in independent claim 216, Scharpf et al. does not enable, teach or suggest "An engine comprising a combustion camber, wherein a-mixture of oxygen, as O_2, and hydrogen, as H_2, are combusted" as claimed in independent claim 216.

Examiner Statement

Regarding claim 242, Applicant argued US 2406605 (Hurd) does not disclose the mixture of hydrogen with frozen water crystal. The Examiner disagrees. Example 4 mentions about using dry-ice condenser bonded to hydrogen. That inherently forms the hydrogen gel as claimed.

Applicant's Response

Applicant would like to respectfully present to the Examiner that a "dry-ice" condenser does not comprise water. Specifically, dry ice is solid or frozen carbon-dioxide. Referencing Hawley's Chemical Dictionary, dry ice is defined as:

> **Dry ice.** See carbon dioxide.
> **carbon dioxide**, CAS: 124-38-9, CO_2.

This is while there is no teaching in the instant invention or instant claim which discloses the use of carbon dioxide in any form. This is also while the instant invention teaches the use of H_2O to cool the combustion chamber, while instant claim 216 has as a limitation "the temperature of combustion is at least partially controlled with the addition of water to said combustion chamber in a way that maintains combustion or combustion exhaust temperature".

Examiner Statement

Regarding the US 6212876, please note the only teaching from this reference is the concept of using combustion engine to drive a rocket. The hydrogen fuel is already taught in the primary references (Tindell and Hughes).

Applicant's Response

Applicant appreciates the Examiner's clarification.

Examiner Statement

Regarding the rejection of claim 223, Applicant argued the combination is not valid because Scharpf et al discloses the nitrogen air separation unit that is contracted with Applicant's oxygen cryogenic air separation unit. The Examiner disagrees because the air separation unit in Scharpf et al separates both nitrogen in line 86 and oxygen in line 84. Because both oxygen and nitrogen are formed by the air separation unit, the teaching of Scharpf et al is relevant to the claimed invention.

Applicant's Response

Applicant would like to respectfully present to the Examiner that Applicant's argument referred to by the Examiner was responding to the Examiner's argument, which was in relation to the use of nitrogen as taught in Scharpf et al. and wherein there is no such teaching in the instant invention.

Applicant does agree with the Examiner that Scharpf et al. teach the separation of air into both nitrogen and oxygen. However, the use of oxygen in Scharpf et al. is in coal gasifier [70]. Specifically, Scharpf et al. in col. 4 lines 29 - 40 states:

> In air separation unit 80, compressed air, in line 82, is cryogenically separated into an elevated pressure, oxygen product and an elevated pressure, nitrogen product. It is important to note in the present invention that the source of the compressed air, in line 82, can be from a stand alone air compressor or in whole or in part from compressor 20. The elevated pressure, oxygen product, in line 84, is fed to coal gasifier 70. The elevated pressure, nitrogen product, in line 86, is expanded in expander 90, thereby producing a chilled, low pressure nitrogen stream, in line 92, while producing work to generate electricity.

(Emphasis added)

Such a teaching is in contradiction with the instant invention which only teaches the combustion of oxygen with hydrogen. Independent claim 216 specifically states "An engine comprising a combustion camber, wherein a mixture of oxygen, as O_2, and hydrogen, as H_2, are combusted".

As Scharpf et al. does teach the separation of air into nitrogen and oxygen, Applicant performed a full review of Scharpf et al. to ascertain if there is any enablement, teaching or suggestion to separate air into its oxygen component for use in hydrogen combustion. Applicant is unable to find any enablement, teaching or suggestion in Scharpf et al. to use oxygen, obtained from air separation, in the combustion of hydrogen. Applicant further performed a full review of Scharpf et al. to ascertain if there is any enablement to "power" an air separation unit from a combustion engine. Applicant cannot find any such enablement, teaching or suggestion in Scharpf et al. As a further check, Applicant performed a word search in Scharpf et al. for the words "hydrogen" and "power". The word hydrogen only appears in Scharpf et al. in the description of a gas mixture comprising carbon monoxide and hydrogen. In conclusion, Scharpf et al. does not enable, teach or suggest the use of oxygen from air separation in the combustion of hydrogen. The word "power" is used in relation to nitrogen; however, there is no enablement, teaching or suggestion to "power" air separation by the combustion engine. Even figures 1 and 2 in Scharpf et al. do not mechanically link air separation to the engine. In relation to "power", Scharpf et al. teach in column 3 line 50 to column 4 line 9:

> The improvement to the process, in its primary embodiment, takes the waste nitrogen stream produced by an elevated pressure air separation unit and passes it through an expander to generate power and to chill the nitrogen stream to subambient temperatures. The chilled stream is then fed to the inlet of the air compressor for the gas turbine, displacing some of the ambient temperature air feed. This modification cools and densities the gas turbine compressor feed, increasing the total gas throughput of the gas turbine compressor. As a side

effect, since the nitrogen stream is depleted in oxygen relative to the normal feed air to the gas turbine compressor, the oxygen content of the oxidant will be reduced, resulting in lower peak flame temperatures that will in turn result in lower NO_x generation. A flow diagram of this process is shown in FIG. 1.

With reference to FIG. 1, feed air, in line 10, and chilled, low pressure nitrogen, in line 92, are compressed in gas turbine air compressor 20 to produce a compressed, combustion air stream. This compressed, combustion air stream, in line 22, is then fed to and combusted with fuel gas, in line 62, and, optionally, steam, in line 52, in combustor 30 producing a combustion product stream. This combustion product stream, in line 32, is fed to and expanded in gas turbine expander 40 thereby producing a hot exhaust gas stream and electricity. Typically, gas turbine expander 40 and gas turbine air compressor 20 are mechanically linked.

Therefore, and in conclusion, Scharpf et al. do not teach the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Examiner Statement

Regarding other 103 rejections including Gode, Kang et al, Weidig, Erickson, Thodarson, Applicant argued the modified features from these references do not meet the subject matter of independent claim 216. The Examiner would like to point out that the teachings of these references are used only to reject the limitations of the dependent claims. The independent claims are rejected by the primary references. Also, because all references are from the same field of endeavor, it would have been obvious to modify one reference in view of the other. For the 103 rejections, Applicant should not attack the references individually but must consider the combination as a whole.

Applicant's Response

Applicant would like to respectfully present to the Examiner that each and all of the dependent claims depend on independent claim 216; therefore, citation(s) made by the Examiner to a dependent claim needs to include all of the claim restrictions (or limitations) of the

independent claim, as well as the restrictions (or limitations) of the dependent claim. If a cited reference(s) of the Examiner does not include the claim restrictions (or limitations) within both the dependent claim and the restrictions (or limitations) of the independent claim from which the dependent claim depends, the cited reference cannot teach or suggest the dependent claim which includes the restrictions (or limitations) of both the independent claim and the restrictions (or limitations) of the dependent claim.

As far as obviousness, Applicant would like to respectfully request of the Examiner to present his claim combinations, then, in such a manner so that Applicant can follow which citations are being combined to form the prime facie case of obviousness. This is most important as Applicant needs to identify if all claim limitations are taught within the cited reference(s); and if so, whether there is any motivation to combine within the Examiner's cited reference(s).

In addition to the above, Applicant would like to respectfully present to the Examiner that once Applicant has traversed a Prime Facie case of the Examiner relating to the independent claim, in this case claim 216, that Applicant has also traversed any claim which depends upon the independent claim, reference MPEP 2143.03.

Applicant would also respectfully wish to add that Applicant presents within this Office Action Response two declarations which demonstrate that the instant invention answers a "long felt need" as described in MPEP 716.04.

Examiner's 35 U.S.C. 103 (a) Rejections

The Examiner Rejects

Claims 216-220, 222, 223, 224, 238-240, 243, 248-253, 258, 342, are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of U.S. 5388395 (Scharpf et al).

Tindell discloses a solar energy system comprising an electrolysis chamber 13 for forming hydrogen being stored in an hydrogen tank 22, oxygen being stored in an oxygen tank 21, a combustion chamber 33 for burning said hydrogen and oxygen, water input nozzle 31 for injecting water into the combustion chamber, said combustion

chamber is then acting as a steam generator to generate steam to drive a steam turbine 47 to generate electricity through a generator 48. Tindell does not teach the air separation unit being powered partly by the combustion energy. Scharpf et al discloses an air separation unit 80 being powered partly by the steam (column 4, lines 20-22), which is a part of the combustion power. It would have been obvious to provide an air separation unit in Tindell as taught by Scharpf et al for the purpose of more effectively forming oxygen for the combustion process. Regarding claim 223, Tindell does not disclose the use of nitrogen. Scharpf et al is relied upon to disclose it's well known to use nitrogen in the inlet of the combustion chamber for the purpose of improving the separation unit being powered partly by the combustion energy. Scharpf et al discloses an air separation unit 80 being powered partly by the steam (column 4, lines 20-22), which is a part of the combustion power. It would have been obvious to provide an air separation unit in Tindell as taught by Scharpf et al for the purpose of more effectively forming oxygen for the combustion process. Regarding claim 223, Tindell does not disclose the use of nitrogen. Scharpf et al is relied upon to disclose it's well known to use nitrogen in the inlet of the combustion chamber for the purpose of improving the cooling function of the input fluid. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to inject nitrogen in Tindell as taught by Scharpf et al for the purpose of improving the cooling function of the input fluid.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. (nor is there in Tindell as previously presented) to power the separation of air by a combustion engine of any type, much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam

to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation". Nor does the combination of cited references include the claim limitation "the temperature of combustion is at least partially controlled with the addition of water to said combustion chamber in a way that maintains combustion or combustion exhaust temperature".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 216-220, 222, 223, 224, 238-240, 243, 248-253, 258, and 342 as amended herein.

The Examiner Rejects

Claims 216-220, 222, 223, 224, 228-229, 238-240, 243, 248-253, 258, 342, are rejected under 35 U.S.C. § 103(a) as being unpatentable over US 3459953 (Hughes et al) in view of Scharpf et al.

Hughes et al discloses a solar energy system comprising an electrolysis chamber 16 for forming hydrogen being stored in an hydrogen tank 20, oxygen being stored in an oxygen tank 22, a combustion chamber 24 for burning said hydrogen and oxygen, water input nozzle 48 for injecting water into the combustion chamber, said combustion chamber is then acting as a steam generator to generate steam to drive a steam turbine 32 to generate electricity through a generator 36. Note the electrical input 10 can be from any sources (column 2, lines 15-16), so it's clear that the electricity from the generator 36 can be used too. Hughes et.al does not teach the air separation unit being powered partly by the combustion energy. Scharpf et al discloses an air separation unit 80 being powered partly by the steam (column 4, lines 20-22), which is a part of the combustion power. It would have been obvious to provide an air separation unit in

Hughes et al as taught by Scharpf et al for the purpose of more effectively forming oxygen for the combustion process. Regarding claim 223, Hughes et al does not disclose the use of nitrogen. Scharpf et al is relied upon to disclose it's well known to use nitrogen in the inlet of the combustion chamber for the purpose of improving the cooling function of the input fluid. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to inject nitrogen in Hughes et al as taught by Scharpf et al for the purpose of improving the cooling function of the input fluid.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Hughes as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 216-220, 222, 223, 224, 238-240, 243, 248-253, 258, and 342 as amended herein.

Examiner Rejection

Claims 225-227 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and U.S. 5899072 (Godé). Tindell as

modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of corrosion to form hydrogen. Gode is relied upon to disclose it's well known to use corrosion to form hydrogen (column 1, lines 36-49). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to form hydrogen by corrosion in Tindell as taught by Gode for the purpose of generating more hydrogen if needed.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Gode as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 225-227 as amended herein.

Examiner Rejects

Claims 231, 235 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and U.S. 5516359 (Kang et al). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of air separation unit with membrane. Kang et al is relied upon to disclose it's well known to use air separation unit 107 with membrane 108 for

separating air. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use an air separation unit with membrane in Tindell as taught by Kang et al for the purpose of separating air to form more important components if needed.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Kang et al. as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 231 and 235 as amended herein.

Examiner Rejects

Claim 237 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and U.S. 4440545 (Weidig). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of corrosion inhibitor. Weidig is relied upon to disclose it's well known to use corrosion inhibitor in a combustion chamber. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use corrosion

inhibitor in Tindell as taught by Weidig for the purpose of inhibiting corrosion in the combustion chamber.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Weidig as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claim 237 as amended herein.

Examiner Rejects

Claim 241 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and U.S. 3975913 (Erickson). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of fuel cell. Erickson is relied upon to disclose it's well known to use fuel cell 1 to work in combination with an electrolysis chamber. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use fuel cell in Tindell as taught by Erickson for the purpose of generating the appropriate amount of hydrogen and oxygen.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Erickson as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claim 241 as amended herein.

Examiner Rejects

Claim 242 is rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and US 2406605 (Hurd et al). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of gel storage. US 2406605 (Hurd et al) discloses the concept of converting hydrogen into hydrogen gel by treating the hydrogen in the dry condenser, note example 4 in column 3. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use gel storage in Tindell as taught by Hurd et al for the purpose of ease of storing hydrogen.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Hurd as previously presented), much less

from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Also, Hurd teaches in Example 4 column 3:

Example 4

Methyltrichlorosilane in vapor form (density= 1.27) together with hydrogen chloride gas was passed in 2:1 ratio over aluminum granules at 350°. A liquid product of density 1.25 was condensed from the reaction products by means of a Dry-Ice condenser. Hydrolysis of a portion of this product gave a gel which upon treatment with alkali solution reacted with a vigorous evolution of gas. Distillation of the product revealed the presence of compounds more volatile than methyltrichlorosilane, which compounds were found to contain larger amounts of Si-bonded hydrogen than the gel.

(Emphasis added)

Therefore, Hurd does not teach a hydrogen gel formed with water crystals. The only teaching in Hurd, within the cited Example, relates to hydrogen chloride gas. As a further check, Applicant performed a search within Hurd from beginning to end finding no teaching to form a hydrogen gel by mixing hydrogen with water crystals. Applicant did locate in column 1 lines 1 – 7 a description of the teachings within Hurd, specifically:

The present invention relates to the hydrogenation of halogenosilanes. It is particularly concerned with a method of substituting hydrogen atoms for at least some of the silicon-bonded halogen atoms in a highly halogenated chlorosilane to obtain the corresponding hydrogen compounds.

Therefore, Hurd teaches "halogenation of halogenosilanes. There are no halogenosilanes in the instant invention.

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claim 242 as amended herein.

Examiner Rejects

Claims 259-260, 350, are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and US 6212876 (Gregory et al). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the jet propulsion rocket. US 6212876 (Gregory et al) teaches a rocket propulsion engine using combustion engine. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use jet propulsion rocket in Tindell as taught by Gregory et al for the purpose of driving rocket if needed (note it's well known to use combustion engine such as gas engine to produce thrust in aircraft/rocket design).

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Gregory as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 259-260 and 350 as amended herein.

Examiner Rejects

Claims 244-247 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 4841731 (Tindell) in view of Scharpf and U.S. 6698183 (Thordarson). Tindell as modified by Scharpf discloses all the claimed subject matter as set forth above, but does not disclose the use of flywheel and transmission. Thordarson is relied upon to disclose it's well known to use flywheel 176 and transmission 178 for transmitting power from a combustion chamber/engine 22. It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use flywheel and transmission in Tindell as taught by Thordarson for the purpose of transmitting power output of the combustion engine.

Applicant's Response

As previously stated by Applicant within this response and amendment, there is no enablement, teaching or suggestion within Scharpf et al. to power the separation of air by a combustion engine of any type (nor is there in Tindell or Thordarson as previously presented), much less from a combustion engine which has hydrogen as a fuel. (In contrast, Scharpf et al. teach the use of steam to regenerate adsorbers.) Therefore, regardless of the lack of motivation to combine the cited references within either of the cited references, the combination of the cited references does not contain all of the claim limitations within independent claim 216. Specifically, the combination of cited references does not include the claim limitation "at least a portion of the energy of combustion powers at least a portion of said air separation".

Lastly, and most importantly, as stated herein, Applicant would like to respectfully present to the Examiner that the instant claim(s) of the instant invention answer a "long felt need" which has been known by those of ordinary skill in the art and which has not been answered by those of ordinary skill in the art, ref. MPEP 716.04.

Applicant herein respectfully requests an allowance of claims 244-247 as amended herein.

Instant Invention and Instant Claims Answer a Long Felt Need

In addition to Applicant's presentations that the citation reference combinations presented by the Examiner do not include all of the claim limitations present in independent

claim 216 (and thereby do not include all of the claim limitations within any claim which depends on independent claim 216), Applicant presents independent evidence that the instant invention and the instant invention claims answer a long felt need, ref. MPEP 716.04.

Applicant has presented the instant invention and the instant invention claims to two professionals. The first professional being Mr. Colin Francis Walker, Engineer, a person who would be considered of ordinary skill in the art. The second professional being Mr. Chester Vaughan, Engineer, a person who would be considered of expert skill in the art.

Mr. Vaughan has just recently retired from a distinguished career at the National Aeronautics and Space Administration (NASA). At NASA, Mr. Vaughan stated that he "[w]orked on the Gemini, Apollo, Skylab, Space Shuttle and the International Space Station systems" while "[m]ost of that time I worked in the technical disciplines associated with space propulsion and power systems dealing with high energy propellants and reactants and the associated hardware to make those system function efficiently and safely on manned spacecraft". Further, Mr. Vaughan states "I spent approximately 10 years managing a test facility that dealt with rocket engines, pyrotechnic devices, cryogenic fluids (Oxygen, Hydrogen, Nitrogen and Helium), hydraulic systems and turbine and internal combustion engines". Mr. Vaughan "[w]as the Chief Engineer when [I] retired".

Mr. Vaughan states in his declaration:

"Based on my experience, I believe I should be viewed as someone of expert skill in the art of combustion science and engineering. Based on my review of Mr. Haase's patent application, and technical discussions with Mr. Haase, I believe that this patent includes a unique approach to solving a problem which would ***satisfy a long felt need for humanity, a combustion process without the combustion byproducts of nitrogen and carbon (Carbon Monoxide, Carbon Dioxide, Oxides of Nitrogen, etc.) while still producing efficient shaft power with most of the desirable features of the current Internal Combustion Engine***. The use of pure Oxygen instead of air eliminates the dilution effect of nitrogen which allows significant lower peak combustion pressure for the same torque when compared with the current internal combustion engines (or higher torque with comparable peak combustion pressure). While, the industry has pursued and is pursuing, options such as pollution control equipment on the current Internal combustion engines, battery and fuel cell electric motor driven systems (including hybrids) to deal with this long felt need for humanity, they all have significant disadvantages when

compared with the concept described by Mr. Haase in his patent application (U. S. Patent Application 10/790,316). The following is a more detailed discussion of the pertinent features and benefits of the patent:

a. A method of hydrogen combustion which produces no oxides of carbon and no oxides of nitrogen has been a long felt need of humanity; no solution has been previously presented. Previous and on-going attempts of others to solve this long felt need include, but are not limited to, fuel cells, batteries and electric motors and the combustion of hydrogen with air. Fuel cells, utilizing air for its source of oxygen, are less desirable due to many factors including, but not limited to: equipment cost, platinum availability, and the production of oxides of nitrogen. Combustion of hydrogen with air is proving a challenge due to the production of oxides of nitrogen and due to the available torque per cubic inch of displacement. This is all while the environmental consequences increase daily of humanity's combustion of hydrocarbon fuel. I would also state that said long felt industry need has been known by those of ordinary skill in the art, as well as those of expert skill in the art, of combustion engines and of combustion furnaces for a considerable time previous to the priority date of Mr. Haase's patent application, U.S. Patent Application 10/790,316.

b. A method of hydrogen combustion which produces little to no oxides of carbon nor of nitrogen has been a long felt need which has been known by those or ordinary and of expert skill in the art of combustion and of turbo-machinery for many years, wherein there has not been previously presented a solution.

c. At this time there is no known method or apparatus to combust hydrogen with a pure form of oxygen without storage of oxygen, a rather combustible and dangerous material to store.

d. I would state that a method or apparatus to combust hydrogen with a pure form of oxygen, as described in U.S. Patent Application 10/790,316 and claimed therein, answers said long felt need.

e. As I have read and understand, the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure

form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air as a means to provide a pure form of oxygen to combustion. It is my opinion that this technique and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

f. As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air to provide a pure form of oxygen to combustion. It is my understanding that this approach will increase the amount of hydrogen and of oxygen in the combustion chamber, thereby improving available torque per cubic inch of combustion chamber. It is my opinion that this technique and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

g. As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air to provide a pure form of oxygen to combustion while using the available cryogenic nitrogen as a means of reducing the temperature of stored hydrogen to a temperature below the joule Thompson curve of hydrogen, thereby improving the storage effectiveness of hydrogen. It is my opinion that this approach and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

h. As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, the techniques and methods discussed above, including the benefits can be applied to jet engines, e.g. turbo-machinery. It is my opinion that this technique and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

i. While the invention and apparatus described by Mr. Haase and the U.S, Patent Application 10/790.316 represent significant advantages over the current

approaches, they also represent some significant development challenges which must be overcome to be successful. However, with advances in materials technology, control technology, etc., I believe the patent should be granted and the concept developed.

As combustion methods, engines and devices is a significant market and as there exist many marketed devices within the combustion, engine and turbo-machinery industries in combination with a world wide knowledge of the environmental consequences of hydrocarbon combustion methods, there should not previously nor today exist any lack of interest or lack of appreciation of an invention's potential or marketability to a method or apparatus as presented in the invention of Mr. Haase, U.S. Patent Application 10/348,071."

Mr. Walker states that "I have been an engineer in the combustion industry with an emphasis on turbo-machinery since 1960. I am a founding member of the ASE Society of Materials Engineering while a member of the American Society of Mechanical Engineers (ASME), having authored papers therein for turbo-machinery repair. I am currently a practicing materials engineer for turbo-machinery."

Mr. Walker states in his declaration:

"I should be viewed as at least someone of ordinary skill in the art of combustion engineering and of turbo-machinery.

A method of hydrogen combustion which produces reduced to no oxides of carbon and reduced to no oxides of nitrogen has been a long felt need of humanity; there has not been previously presented a solution. Previous attempts and failure of others to solve this long felt need include, but are not limited to, fuel cells and the combustion of hydrogen with air. Fuel cells are proving impractical due to many factors including, but not limited to: equipment cost, platinum availability, and the production of oxides of nitrogen. Combustion of hydrogen with air is proving a challenge due to the production of oxides of nitrogen and due to the available torque per cubic inch of displacement. This is all while the environmental consequences increase daily of humanity's combustion of hydrocarbon fuel. I would also state that said long felt industry need has been known by those of ordinary skill in the art, as well as those of expert skill in the art, of combustion

engines and of combustion furnaces for a considerable time previous to the priority date of Mr. Haase's patent application, U.S. Patent Application 10/790,316.

A method of hydrogen combustion which produces little to no oxides of carbon nor of nitrogen has been a long felt need which has been known by those or ordinary and of expert skill in the art of combustion and of turbo-machinery for many years, wherein there has not been previously presented a solution.

At this time there is no known method or apparatus to combust hydrogen with a pure form of oxygen without storage of oxygen. This is while oxygen is a rather combustible and dangerous material to store.

I would state that a method or apparatus to combust hydrogen with a pure form of oxygen, as taught in U.S. Patent Application 10/790,316 and claimed therein, answers said long felt need.

As I have read and understand, the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air as a means to provide a pure form of oxygen to combustion. It is my opinion that this teaching and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air to provide a pure form of oxygen to combustion. It is my understanding that this teaching will increase the amount of hydrogen and of oxygen in the combustion chamber, thereby improving available torque per cubic inch of combustion chamber. It is my opinion that this teaching and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to

cryogenically distill air to provide a pure form of oxygen to combustion while using the available cryogenic nitrogen as a means of reducing the temperature of stored hydrogen to a temperature below the joule Thompson curve of hydrogen, thereby improving the storage effectiveness of hydrogen. It is my opinion that this teaching and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with an excess amount of air so as to use the combustion envelop of hydrogen in combination with an amount of air in excess of that required to perform combustion as a means of cooling combustion and thereby reduce the formation of oxides of nitrogen. I also understand that the invention of Mr. Haase, 10/790,316, preferably proposes this teaching for jet engines, e.g. turbo-machinery. It is my opinion that this teaching and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity.

As combustion methods, engines and devices is a significant market and as there exist many marketed devices within the combustion, engine and turbo-machinery industries in combination with a world wide knowledge of the environmental consequences of hydrocarbon combustion methods, there should not previously nor today exist any lack of interest or lack of appreciation of an invention's potential or marketability to a method or apparatus as presented in the invention of Mr. Haase, U.S. Patent Application 10/348,071."

Therefore, it is the professional opinion of one of whom would be considered of expert skill in the art, as well as the opinion of one of ordinary skill in the art, that the instant invention and instant invention claims answer a long felt need for humanity. Specifically, Mr. Vaughan, a distinguished propulsion engineer from NASA, states:

✓ "I believe that this patent includes a unique approach to solving a problem which would satisfy a long felt need for humanity, a combustion process without the combustion byproducts of nitrogen and carbon (Carbon Monoxide, Carbon Dioxide, Oxides of Nitrogen, etc.) while still producing efficient shaft power with most of the desirable features of the current Internal Combustion Engine."

- ✓ "A method of hydrogen combustion which produces no oxides of carbon and no oxides of nitrogen has been a long felt need of humanity; no solution has been previously presented. Previous and on-going attempts of others to solve this long felt need include, but are not limited to, fuel cells, batteries and electric motors and the combustion of hydrogen with air."

- ✓ "I would state that a method or apparatus to combust hydrogen with a pure form of oxygen, as described in U.S. Patent Application 10/790,316 and claimed therein, answers said long felt need."

- ✓ "As I have read and understand, the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air as a means to provide a pure form of oxygen to combustion. It is my opinion that this technique and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity."

- ✓ "As combustion methods, engines and devices is a significant market and as there exist many marketed devices within the combustion, engine and turbo-machinery industries in combination with a world wide knowledge of the environmental consequences of hydrocarbon combustion methods, there should not previously nor today exist any lack of interest or lack of appreciation of an invention's potential or marketability to a method or apparatus as presented in the invention of Mr. Haase, U.S. Patent Application 10/348,071."

And, specifically, Mr. Walker, an accomplished engineer, states:

- ✓ "A method of hydrogen combustion which produces reduced to no oxides of carbon and reduced to no oxides of nitrogen has been a long felt need of humanity; there has not been previously presented a solution. Previous attempts and failure of others to solve this long felt need include, but are not limited to, fuel cells and the combustion of hydrogen with air."

- ✓ "I would also state that said long felt industry need has been known by those of ordinary skill in the art, as well as those of expert skill in the art, of combustion engines and of

combustion furnaces for a considerable time previous to the priority date of Mr. Haase's patent application, U.S. Patent Application 10/790,316."

✓ "As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with a pure form of oxygen, wherein a portion of the combustion energy is used to cryogenically distill air to provide a pure form of oxygen to combustion."

✓ "As I have read and understand the invention of Mr. Haase, U.S. Patent Application 10/790,316, proposes a method and an apparatus to combust a pure form of hydrogen with an excess amount of air so as to use the combustion envelop of hydrogen in combination with an amount of air in excess of that required to perform combustion as a means of cooling combustion and thereby reduce the formation of oxides of nitrogen. I also understand that the invention of Mr. Haase, 10/790,316, preferably proposes this teaching for jet engines, e.g. turbo-machinery. It is my opinion that this teaching and the claims therein answer a long felt industry need known by those of ordinary and of expert skill in the art, as well as a long felt need of humanity."

✓ "As combustion methods, engines and devices is a significant market and as there exist many marketed devices within the combustion, engine and turbo-machinery industries in combination with a world wide knowledge of the environmental consequences of hydrocarbon combustion methods, there should not previously nor today exist any lack of interest or lack of appreciation of an invention's potential or marketability to a method or apparatus as presented in the invention of Mr. Haase, U.S. Patent Application 10/348,071."

Applicable Case Law

MPEP 2143.03

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under **35 U.S.C. 103**, then any claim depending

therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

MPEP 716.04

Establishing long-felt need requires objective evidence that an art recognized problem existed in the art for a long period of time without solution. The relevance of long-felt need and the failure of others to the issue of obviousness depends on several factors. First, the need must have been a persistent one that was recognized by those of ordinary skill in the art. *In re Gershon*, 372 F.2d 535, 539, 152 USPQ 602, 605 (CCPA 1967) ("Since the alleged problem in this case was first recognized by appellants, and others apparently have not yet become aware of its existence, it goes without saying that there could not possibly be any evidence of either a long felt need in the . . . art for a solution to a problem of dubious existence or failure of others skilled in the art who unsuccessfully attempted to solve a problem of which they were not aware."); *Orthopedic Equipment Co., Inc. v. All Orthopedic Appliances, Inc.*, 707 F.2d 1376, 217 USPQ 1281 (Fed. Cir. 1983) (Although the claimed invention achieved the desirable result of reducing inventories, there was no evidence of any prior unsuccessful attempts to do so.).

Second, the long-felt need must not have been satisfied by another before the invention by applicant. *Newell Companies v. Kenney Mfg. Co.*, 864 F.2d 757, 768, 9 USPQ2d 1417, 1426 (Fed. Cir. 1988) (Although at one time there was a long-felt need for a "do-it-yourself" window shade material which was adjustable without the use of tools, a prior art product fulfilled the need by using a scored plastic material which could be torn. "[O]nce another supplied the key element, there was no long-felt need or, indeed, a problem to be solved".)

Third, the invention must in fact satisfy the long-felt need. *In re Cavanagh*, 436 F.2d 491, 168 USPQ 466 (CCPA 1971).

Long-felt need is analyzed as of the date the problem is identified and articulated, and there is evidence of efforts to solve that problem, not as of the date of the most pertinent prior art references. *Texas Instruments Inc. v. Int'l Trade Comm'n*, 988 F.2d 1165, 1179, 26 USPQ2d 1018, 1029 (Fed. Cir. 1993).

CONCLUSION

In view of the foregoing, Applicant believes that the claims as presently amended, are in order for allowance; Applicant respectfully requests favorable reconsideration of this response and amendment, and allowance of the claims at the earliest opportunity.

Applicant has respectfully presented argument which demonstrates that the Examiner's cited reference combinations do not enable, teach or suggest the instant invention.

Applicant has further respectfully presented secondary considerations in the form of two declarations, one from a person of ordinary skill in the art and one from a person of expert skill in the art, both of which demonstrate that the instant invention and the instant invention claims answer a long felt need, which has been recognized by those of ordinary skill in the art for some time and which was not answered prior to the filing of the instant invention.

Applicant appreciates the time and effort afforded by the Examiner in the prosecution of the instant claims for the instant invention.

As Applicant has respectfully traversed all of the Examiner's rejections, Applicant herein requests the award certificate for the instant claims as amended and presented herein.

Respectfully submitted,

Date: September 30, 2006

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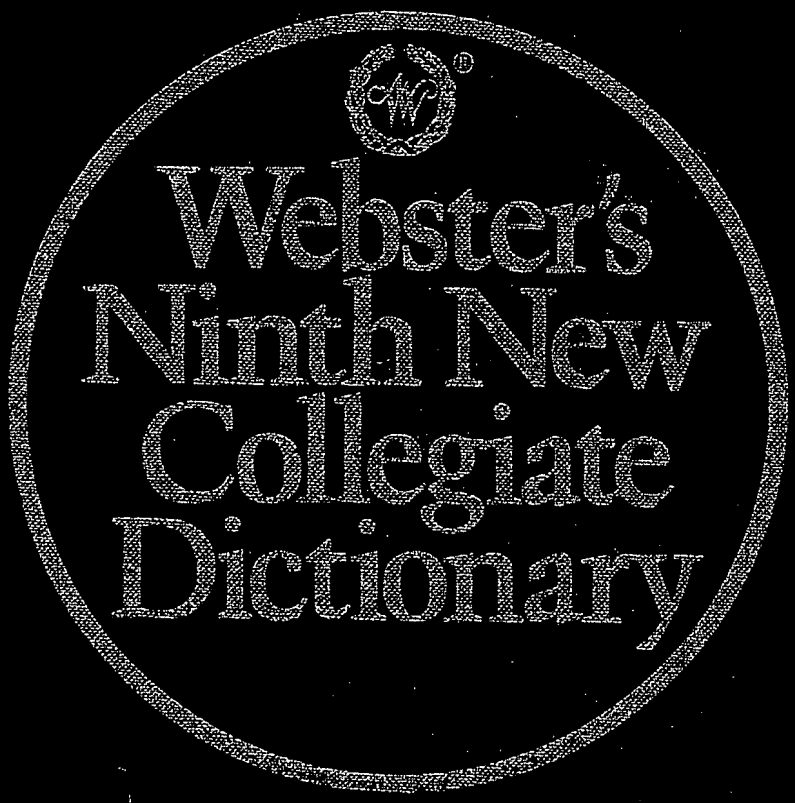

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[1]pound \'paůnd\ *n, pl* **pounds** *also* **pound** [ME, fr. OE *pund*, fr. L *pondo* pound; akin to L *pondus* weight — more at PENDANT] (bef. 12c) **1** : any of various units of mass and weight; *specif* : a unit now in general use among English-speaking peoples equal to 16 avoirdupois ounces or 7000 grains or 0.45359237 kilogram — called also *avoirdupois pound*; see WEIGHT table **2 a** : the basic monetary unit of the United Kingdom — called also *pound sterling* **b** : any of numerous basic monetary units of other countries — see MONEY table **c** : the basic monetary unit of Israel *until* 1980

[2]pound *vb* [alter. of ME *pounen*, fr. OE *pūnian*] *vt* (bef. 12c) **1** : to reduce to powder or pulp by beating **2 a** : to strike heavily or repeatedly **b** : to produce with or as if with repeated vigorous strokes — usu. used with *out* ⟨~ out a story on the typewriter⟩ **c** : to inculcate by insistent repetition : DRIVE ⟨day after day the facts were *~ed* home to them —Ivy B. Priest⟩ **3** : to move along heavily or persistently ⟨*~ed* the pavements looking for work⟩ ~ *vi* **1** : to strike heavy repeated blows **2 a** : to move with or make a heavy repetitive sound **b** : to work hard and continuously — used with *away*

[3]pound *n* (1562) : an act or sound of pounding

[4]pound *n* [ME, enclosure, fr. OE *pund-*] (15c) **1 a** : an enclosure for animals; *esp* : a public enclosure for stray or unlicensed animals ⟨a dog ~⟩ **b** : a depot for holding impounded personal property until redeemed by the owner ⟨a car ~⟩ **2** : a place or condition of confinement **3** : an enclosure within which fish are kept or caught; *esp* : the inner compartment of a fish trap or pound net

[1]pound-age \'paůn-dij\ *n* (ca. 1500) **1** : a charge per pound of weight **2** : weight in pounds

[2]poundage *n* (1554) : the act of impounding : the state of being impounded

pound-al \'paůn-dᵊl\ *n* [*pound* + *-al* (as in *quintal*)] (1879) : a unit of force equal to the force that would give a free mass of one pound an acceleration of one foot per second per second

pound cake *n* [fr. the original recipe prescribing a pound of each of the principal ingredients] (1747) : a rich butter cake made with a large proportion of eggs and shortening

[1]pound-er \'paůn-dər\ *n* (bef. 12c) : one that pounds

[2]pounder *n* (1684) **1** : one having a usu. specified weight or value in pounds — usu. used in combination ⟨caught a ten-*pounder* with his new fishing rod⟩ **2** : a gun throwing a projectile of a specified weight — usu. used in combination ⟨the ship was armed with six-*pounders*⟩

pound-fool-ish \'paůn(d)-'fü-lish\ *adj* [fr. the phrase *penny-wise and pound-foolish*] (1607) : imprudent in dealing with large sums or large matters

pound mile *n* (1939) : the transport of one pound of mail or express for one mile

pound net *n* (1856) : a fish trap consisting of a netting arranged into a directing wing and an enclosure with a narrow entrance

[1]pour \'pȯ(ə)r, 'pō(ə)r\ *vb* [ME *pouren*] *vt* (14c) **1 a** : to cause to flow in a stream **b** : to dispense from a container ⟨*~ed* drinks for everyone⟩ **2** : to supply or produce freely or copiously **3** : to give full expression to : VENT ⟨*~ed* out his feelings⟩ ~ *vi* **1** : to move with a continuous flow **2** : to rain hard **3** : to move or come continuously : STREAM ⟨complaints *~ed in* ⟩ — **pour-able** \'pōr-ə-bəl, 'pór-\ *adj* — **pour-er** \-ər\ *n* — **pour-ing-ly** \-iŋ-lē\ *adv*

[2]pour *n* (1790) **1** : the action of pouring : STREAM **2 a** : an instance of pouring or an amount poured ⟨a ~ of concrete⟩ **b** : a heavy fall of rain : DOWNPOUR

pour-boire \pu(ə)rb-'wär\ *n* [F, fr. *pour boire* for drinking] (1815) : TIP, GRATUITY

pour-par-ler \,pu(ə)r-pär-'lā\ *n* [F] (1795) : a discussion preliminary to negotiations

pour-point \'pu(ə)r-,point, -,pwant\ *n* [ME *purpoint*, fr. MF *pourpoint*] (15c) : a padded and quilted doublet

pour point \'pō(ə)r-,point, 'pó(ə)r-\ *n* (ca. 1922) : the lowest temperature at which a substance flows under specified conditions

pousse-ca-fé \,pü-(,)ska-'fā\ *n* [F, lit., coffee chaser] (1880) : an after-dinner drink consisting of several liqueurs of different colors and specific gravities poured so as to remain in separate layers

pous-sette \pü-'set\ *vi* **pous-sett-ed; pous-sett-ing** [F, game in which contestants cross pins with each attempting to get his pin on top, fr. *pousser* to push] (1812) : to swing in a semicircle with hands joined with one's partner in a country-dance

[1]pout \'paůt\ *vb* [ME *pouten*] *vi* (14c) **1 a** : to show displeasure by thrusting out the lips or wearing a sullen expression **b** : SULK **2** : PROTRUDE ~ *vt* : to cause to protrude ⟨*~ed* her lips⟩

[2]pout *n* (1591) **1** : a protrusion of the lips expressive of displeasure **2** *pl* : a fit of pique

[3]pout *n, pl* **pout** *or* **pouts** [prob. fr. (assumed) ME *poute*, a fish with a large head, fr. OE *-pūte*; akin to ME *pouten* to pout, Skt *budbuda* bubble] (1591) : any of several large-headed fishes (as a bullhead or eelpout)

pout-er \'paůt-ər\ *n* (1809) **1** : one that pouts **2** : a domestic pigeon of a breed characterized by erect carriage and a dilatable crop

pouty \'paůt-ē\ *adj* (1863) : SULKY

pov-er-ty \'päv-ərt-ē\ *n, often attrib* [ME *poverte*, fr. OF *poverté*, fr. L *paupertat-, paupertas*, fr. *pauper* poor — more at POOR] (12c) **1** : the state of one who lacks a usual or socially acceptable amount of money or material possessions **b** : renunciation as a member of a religious order of the right as an individual to own property **2** : SCARCITY, DEARTH **3 a** : debility due to malnutrition **b** : lack of fertility ⟨~ of the soil⟩

syn POVERTY, INDIGENCE, PENURY, WANT, DESTITUTION mean the state of one with insufficient resources. POVERTY may cover a range from extreme want of necessities to an absence of material comforts; INDIGENCE implies seriously straitened circumstances; PENURY suggests a cramping or oppressive lack of money; WANT and DESTITUTION imply extreme poverty that threatens life itself through starvation or exposure.

poverty line *n* (1901) : a level of personal or family income below which one is classified as poor according to governmental standards — called also *poverty level*

pov-er-ty-strick-en \-,strik-ən\ *adj* (1803) : very poor : DESTITUTE

[1]pow \'pō, 'paů\ *n* [alter. of POLL] (1724) : HEAD, POLL

[2]pow \'paů\ *n* [imit.] (1881) : a sound of a blow or explosion

POW \,pē(,)ō-'dəb-əl-(,)yü, -yə(-w), -'dəb(-ə)-yə(-w), -'dəb-yē\ *n* (ca. 1919) : PRISONER OF WAR

[1]pow-der \'paůd-ər\ *n, often attrib* [ME *poudre*, fr. OF, fr. L *pulver-, pulvis* dust — more at POLLEN] (13c) **1** : matter in a finely divided state : particulate matter **2 a** : a preparation in the form of fine particles esp. for medicinal or cosmetic use **b** : fine dry light snow **3** : any of various solid explosives used chiefly in gunnery and blasting

[2]powder *vb* **pow-dered; pow-der-ing** \'paůd-(ə-)riŋ\ *vt* (14c) **1** : to sprinkle or cover with or as if with powder **2** : to reduce or convert to powder **3** : to hit (as a ball) very hard ~ *vi* **1** : to become powder **2** : to apply cosmetic powder — **pow-der-er** \-ər-ər\ *n*

powder blue *n* (1896) : a variable color averaging a pale blue

powder horn *n* (1533) : a flask for carrying gunpowder; *esp* : one made of the horn of an ox or cow

powder keg *n* (1855) **1** : a small usu. metal cask for holding gunpowder or blasting powder **2** : something liable to explode

powder metallurgy *n* (1933) : a branch of science or an art concerned with the production of powdered metals or of metallic objects by compressing a powdered metal or alloy with or without other materials and heating without thoroughly melting to solidify and strengthen

powder monkey *n* (1682) : one who carries or has charge of explosives (as in blasting operations)

powder-puff *adj* (1939) : of, relating to, or being a competitive activity or event for women (a ~ football game)

powder puff *n* (ca. 1704) : a small fluffy device (as a pad) for applying cosmetic powder

powder room *n* (ca. 1937) **1** : a rest room for women **2** : a lavatory in the main living area of a house

pow-dery \'paůd-ə-rē\ *adj* (15c) **1 a** : resembling or consisting of powder ⟨~ snow⟩ **b** : easily reduced to powder : CRUMBLING **2** : covered with or as if with powder

powdery mildew *n* (1889) **1** : a perfect fungus (family Erysiphaceae) or an imperfect fungus (genus *Oidium*) producing abundant powdery conidia on the host **2** : a plant disease caused by a powdery mildew

[1]pow-er \'paů(-ə)r\ *n, often attrib* [ME, fr. OF *poeir, poeir* to be able, fr. (assumed) L *potēre* to be powerful — more at POTENT] (13c) **1** : possession of control, authority, or influence over others **b** : one having such power; *specif* : a sovereign state **c** : a controlling group : ESTABLISHMENT — often used in the phrase *the powers that be* **d** *archaic* : a force of armed men **e** *chiefly dial* : a large number or quantity **2 a** (1) : ability to act or produce an effect (2) : ability to get extra-base hits (3) : capacity for being acted upon or undergoing an effect **b** : legal or official authority, capacity, or right **3 a** : physical might **b** : mental or moral efficacy **c** : political control or influence **4** *pl* : an order of angels — see CELESTIAL HIERARCHY **5 a** : the number of times as indicated by an exponent that a number occurs as a factor in a product; *also* : the product itself **b** : CARDINAL NUMBER **2 6 a** : a source or means of supplying energy; *esp* : ELECTRICITY **b** : MOTIVE POWER **c** : the time rate at which work is done or energy emitted or transferred **7** : MAGNIFICATION 2b **8** : SCOPE, COMPREHENSIVENESS **9** : the probability of rejecting the null hypothesis in a statistical test when a particular alternative hypothesis happens to be true

syn POWER, AUTHORITY, JURISDICTION, CONTROL, COMMAND, SWAY, DOMINION mean the right to govern or rule or determine. POWER implies possession of ability to wield force, permissive authority, or substantial influence; AUTHORITY implies the granting of power for a specific purpose within specified limits; JURISDICTION applies to official power exercised within prescribed limits; CONTROL stresses the power to direct and restrain; COMMAND implies the power to make arbitrary decisions and compel obedience; SWAY suggests the extent or scope of exercised power or influence; DOMINION stresses sovereign power or supreme authority.

syn POWER, FORCE, ENERGY, STRENGTH, MIGHT mean the ability to exert effort. POWER may imply latent or exerted physical, mental, or spiritual ability to act or be acted upon; FORCE implies the actual effective exercise of power; ENERGY applies to power expended or capable of being transformed into work; STRENGTH applies to the quality or property of a person or thing that makes possible the exertion of force or the withstanding of strain, pressure, or attack; MIGHT implies great or overwhelming power or strength.

[2]power *vt* (1540) **1** : to supply with power and esp. motive power **2** : to give impetus to

power base *n* (1959) : a base of political support

pow-er-boat \'paů(-ə)r-,bōt\ *n* (1908) : MOTORBOAT

power broker *n* (1961) : a person (as in politics) able to exert strong influence because of votes or individuals that he controls

pow-er-dive \-,dīv\ *vi* (1937) : to make a power dive ~ *vt* : to cause to power-dive

power dive *n* (1930) : a dive of an airplane accelerated by the power of the engine

pow-er-ful \'paů(-ə)r-fəl\ *adj* (15c) **1** : having great power, prestige, or influence **2** : leading to many or important deductions ⟨a ~ set of postulates⟩ — **pow-er-ful-ly** \-f(ə-)lē\ *adv*

power function *n* (1957) **1** : a function of a parameter under statistical test whose value for a particular value of the parameter is the probability of rejecting the null hypothesis if that value of the parameter happens to be true **2** : a function (as $f(x) = ax^k$) that equals the product of a constant and a power of the independent variable

pow-er-house \'paů(-ə)r-,haůs\ *n* (ca. 1890) **1 a** : POWER PLANT **1 b** : a source of influence or inspiration **2** : one having great drive, energy, or ability

pow-er-less \-ləs\ *adj* (ca. 1552) **1** : devoid of strength or resources **2** : lacking the authority or capacity to act — **pow-er-less-ly** *adv* — **pow-er-less-ness** *n*

power mower *n* (1940) : a motor-driven lawn mower

power of attorney (1747) : a legal instrument authorizing one to act as the attorney or agent of the grantor

power pack *n* (1936) : a unit for converting a power supply (as from a battery or household electrical circuit) to a voltage suitable for an electronic device

power plant *n* (1890) **1** : an electric utility generating station **2** : an engine and related parts supplying the motive power of a self-propelled object (as a rocket or automobile)

refuge *vb* **ref·uged; ref·ug·ing** *vt* (1594) : to give refuge to ~ *vi* : to seek or take refuge

ref·u·gee \ˌref-yu̇-ˈjē, ˈref-yu̇-ˌ\ *n* [F *réfugié*, pp. of (*se*) *réfugier* to take refuge, fr. L *refugium*] (1685) : one that flees; *esp* : one who flees to a foreign country or power to escape danger or persecution — **ref·u·gee·ism** \-ˌiz-əm\ *n*

re·fu·gi·um \ri-ˈfyü-jē-əm\ *n, pl* **-gia** \-jē-ə\ [NL, fr. L, refuge] (1943) : an area of relatively unaltered climate that is inhabited by plants and animals during a period of continental climatic change (as a glaciation) and remains as a center of relict forms from which a new dispersion and speciation may take place after climatic readjustment

re·ful·gence \ri-ˈfu̇l-jən(t)s, -ˈfəl-\ *n* [L *refulgentia*, fr. *refulgent-, refulgens*, prp. of *refulgēre* to shine brightly, fr. *re-* + *fulgēre* to shine — more at FULGENT] (1634) : a radiant or resplendent quality or state : BRILLIANCE — **re·ful·gent** \-jənt\ *adj*

[1]re·fund \ri-ˈfənd, ˈrē-ˌ\ *vt* [ME *refunden*, fr. MF & L; MF *refonder*, fr. L *refundere*, lit., to pour back, fr. *re-* + *fundere* to pour — more at FOUND] (15c) **1** : to give or put back **2** : to return (money) in restitution, repayment, or balancing of accounts — **re·fund·abil·i·ty** \ri-ˌfən-də-ˈbil-ət-ē, (ˌ)rē-\ *n* — **re·fund·able** \-ə-bəl\ *adj*

[2]re·fund \ˈrē-ˌfənd\ *n* (1866) **1** : the act of refunding **2** : a sum refunded

[3]re·fund \(ˈ)rē-ˈfənd\ *vt* [*re-* + *fund*] (ca. 1860) : to fund again

re·fur·bish \ri-ˈfər-bish\ *vt* (ca. 1611) : to brighten or freshen up : RENOVATE — **re·fur·bish·er** *n* — **re·fur·bish·ment** \-bish-mənt\ *n*

re·fus·al \ri-ˈfyü-zəl\ *n* (15c) **1** : the act of refusing or denying **2** : the opportunity or right of refusing or taking before others

[1]re·fuse \ri-ˈfyüz\ *vb* **re·fused; re·fus·ing** [ME *refusen*, fr. MF *refuser*, fr. (assumed) VL *refusare*, fr. L *refusus*, pp. of *refundere* to pour back] *vt* (14c) **1** : to express oneself as unwilling to accept ⟨~ a gift⟩ ⟨~ a promotion⟩ **2 a** : to show or express unwillingness to do or comply with ⟨the motor *refused* to start⟩ **b** : DENY ⟨they were *refused* admittance to the game⟩ **3** *obs* : GIVE UP, RENOUNCE **4** *of a horse* : to decline to jump or leap over ~ *vi* : to withhold acceptance, compliance, or permission *syn* see DECLINE — **re·fus·er** *n*

[2]ref·use \ˈref-ˌyüs, -ˌyüz\ *n* [ME, fr. MF *refus* rejection, fr. OF, fr. *refuser*] (15c) **1** : the worthless or useless part of something : LEAVINGS **2** : TRASH, GARBAGE

[3]ref·use \ˈref-ˌyüs, -ˌyüz\ *adj* (15c) : thrown aside or left as worthless

re·fuse·nik *or* **re·fus·nik** \ri-ˈfyüz-(ˌ)nik\ *n* [[1]*refuse* + *-nik*] (1974) : a Soviet citizen and esp. a Jew who is refused permission to emigrate

ref·u·ta·tion \ˌref-yu̇-ˈtā-shən\ *n* (1548) : the act or process of refuting

re·fute \ri-ˈfyüt\ *vt* **re·fut·ed; re·fut·ing** [L *refutare*, fr. *re-* + *-futare* to beat — more at BEAT] (1597) **1** : to prove wrong by argument or evidence : show to be false or erroneous **2** : to deny the truth or accuracy of ⟨*refuted* the election returns which showed him the loser⟩ — **re·fut·able** \-ˈfyüt-ə-bəl\ *adj* — **re·fut·ably** \-blē\ *adv* — **re·fut·er** *n*

reg \ˈreg\ *n* [by shortening] (ca. 1925) : REGULATION ⟨federal ~s⟩

re·gal \ˈrē-gəl\ *adj* [ME, fr. MF or L; MF, fr. L *regalis* — more at ROYAL] (14c) **1** : of, relating to, or suitable for a king **2** : of notable excellence or magnificence : SPLENDID — **re·gal·i·ty** \ri-ˈgal-ət-ē\ *n* — **re·gal·ly** \ˈrē-gə-lē\ *adv*

[1]re·gale \ri-ˈgā(ə)l\ *vb* **re·galed; re·gal·ing** [F *régaler*, fr. MF, fr. *regale*, n.] *vt* (ca. 1656) **1** : to entertain sumptuously : feast with delicacies **2** : to give pleasure or amusement to ⟨*regaled* us with stories of his exploits⟩ ~ *vi* : to feast oneself : FEED

[2]regale *n* [F *régal*, fr. MF *regale*, fr. *re-* + *galer* to have a good time — more at GALLANT] (1670) **1** : a sumptuous feast **2** : a choice piece esp. of food

re·ga·lia \ri-ˈgāl-yə\ *n pl* [ML, fr. L, neut. pl. of *regalis*] (1540) **1** : royal rights or prerogatives **2 a** : the emblems, symbols, or paraphernalia indicative of royalty **b** : decorations or insignia indicative of an office or membership **3** : special dress; *esp* : FINERY

[1]re·gard \ri-ˈgärd\ *n* [ME, fr. MF, fr. OF, fr. *regarder*] (14c) **1** *archaic* : APPEARANCE **2 a** : ATTENTION, CONSIDERATION ⟨due ~ should be given to all facets of the question⟩ **b** : a protective interest : CARE ⟨ought to have more ~ for his health⟩ **3** : LOOK, GAZE **4 a** : the worth or estimation in which something or someone is held ⟨a man of small ~⟩ **b (1)** : a feeling of respect and affection : ESTEEM ⟨his hard work won him the ~ of his colleagues⟩ **(2)** *pl* : friendly greetings implying such feeling ⟨give him my ~s⟩ **5** : a basis of action or opinion : MOTIVE **6** : an aspect to be taken into consideration : RESPECT ⟨is a small school, and is fortunate in this ~⟩ **7** *obs* : INTENTION — **in regard to** : with respect to : CONCERNING — **with regard to** : in regard to

[2]regard *vb* [ME *regarden*, fr. MF *regarder* to look back at, regard, fr. OF, fr. *re-* + *garder* to guard, look at — more at GUARD] *vt* (15c) **1** : to pay attention to : take into consideration or account **2 a** : to show respect or consideration for **b** : to hold in high esteem **3** : to look at **4** *archaic* : to relate to **5** : to consider and appraise usu. from a particular point of view ⟨is highly ~*ed* as a mechanic⟩ ~ *vi* **1** : to look attentively : GAZE **2** : to pay attention : HEED

syn REGARD, RESPECT, ESTEEM, ADMIRE mean to recognize the worth of a person or thing. REGARD is a general term that is usu. qualified ⟨he is not highly *regarded* in the profession⟩ RESPECT implies a considered evaluation or estimation ⟨after many years they came to *respect* her views⟩ ESTEEM implies greater warmth of feeling accompanying a high valuation ⟨no citizen of the town was more highly *esteemed*⟩ ADMIRE suggests usu. enthusiastic appreciation and often deep affection ⟨a friend that I truly *admire*⟩

— **as regards** : with respect to : CONCERNING

re·gar·dant \ri-ˈgärd-ᵊnt\ *adj* [MF, prp. of *regarder*] (15c) : looking backward over the shoulder — used of a heraldic animal

re·gard·ful \ri-ˈgärd-fəl\ *adj* (1586) **1** : HEEDFUL, OBSERVANT **2** : full or expressive of regard or respect : RESPECTFUL — **re·gard·ful·ly** \-fə-lē\ *adv* — **re·gard·ful·ness** *n*

re·gard·ing *prep* (1890) : with respect to : CONCERNING

[1]re·gard·less \ri-ˈgärd-ləs\ *adj* (1591) : HEEDLESS, CARELESS — **re·gard·less·ly** *adv* — **re·gard·less·ness** *n*

[2]regardless *adv* (1872) : despite everything ⟨went ahead with their plans ~⟩

regardless of *prep* (1784) : without taking into account ⟨accepts all *regardless of* age⟩; *also* : in spite of ⟨*regardless of* our mistakes⟩

re·gat·ta \ri-ˈgät-ə, -ˈgat-\ *n* [It] (1652) : a rowing, speedboat, or sailing race or a series of such races

re·ge·la·tion \ˌrē-jə-ˈlā-shən\ *n* (1857) : the freezing again of water derived from ice melting under pressure when the pressure is relieved

re·gen·cy \ˈrē-jən-sē\ *n, pl* **-cies** (15c) **1** : the office, jurisdiction, or government of a regent or body of regents **2** : a body of regents **3** : the period of rule of a regent or body of regents

Regency *adj* (1938) : of, relating to, or characteristic of the styles of George IV's regency as Prince of Wales during the period 1811–20

re·gen·er·a·cy \ri-ˈjen-(ə-)rə-sē\ *n* (1626) : the state of being regenerated

[1]re·gen·er·ate \ri-ˈjen-(ə-)rət\ *adj* [ME *regenerat*, fr. L *regeneratus*, pp. of *regenerare* to regenerate, fr. *re-* + *generare* to beget — more at GENERATE] (15c) **1** : formed or created again **2** : spiritually reborn or converted **3** : restored to a better, higher, or more worthy state — **re·gen·er·ate·ly** *adv* — **re·gen·er·ate·ness** *n*

[2]re·gen·er·ate \ri-ˈjen-ə-ˌrāt\ *vi* (1541) **1** : to become formed again **2** : to become regenerate : REFORM **3** : to undergo regeneration ~ *vt* **1 a** : to subject to spiritual regeneration **b** : to change radically and for the better **2 a** : to generate or produce anew; *esp* : to replace (a body part) by a new growth of tissue **b** : to produce again chemically sometimes in a physically changed form **3** : to restore to original strength or properties **4** : to increase the amplification of (an electron current) by causing part of the power in the output circuit to act upon the input circuit — **re·gen·er·a·ble** \-ˈjen-(ə-)rə-bəl\ *adj*

[3]re·gen·er·ate \-ˈjen-(ə-)rət\ *n* (1569) : one that is regenerated: as **a** : an individual who is spiritually reborn **b (1)** : an organism that has undergone regeneration **(2)** : a regenerated body part

regenerated cellulose *n* (1904) : cellulose obtained in a changed form by chemical treatment (as of a cellulose solution or derivative)

re·gen·er·a·tion \ri-ˌjen-ə-ˈrā-shən, ˌrē-\ *n* (14c) **1** : an act or the process of regenerating : the state of being regenerated **2** : spiritual renewal or revival **3** : renewal or restoration of a body or bodily part after injury or as a normal process **4** : utilization by special devices of heat or other products that would ordinarily be lost

re·gen·er·a·tive \ri-ˈjen-ə-ˌrāt-iv, -ˈjen-(ə-)rət-\ *adj* (15c) **1** : of, relating to, or marked by regeneration **2** : tending to regenerate

re·gen·er·a·tor \ri-ˈjen-ə-ˌrāt-ər\ *n* (ca. 1550) **1** : one that regenerates **2** : a device used esp. with hot-air engines or gas furnaces in which incoming air or gas is heated by contact with masses (as of brick) previously heated by outgoing hot air or gas

re·gent \ˈrē-jənt\ *n* [ME, fr. MF or ML; MF, fr. ML *regent-, regens*, fr. L, prp. of *regere* to rule — more at RIGHT] (15c) **1** : one who governs a kingdom in the minority, absence, or disability of the sovereign **2** : one who rules or reigns : GOVERNOR **3** : a member of a governing board (as of a state university) — **regent** *adj* — **re·gent·al** \-jən-tᵊl\ *adj*

reg·gae \ˈreg-(ˌ)ā, ˈrāg-\ *n* [origin unknown] (1968) : popular music of Jamaican origin that combines indigenous styles with elements of rock 'n' roll and soul music and is performed at moderate tempos with the accent on the offbeat

reg·i·cide \ˈrej-ə-ˌsīd\ *n* (1548) **1** [prob. fr. (assumed) NL *regicida*, fr. L *reg-, rex* king + *-cida* -cide — more at ROYAL] : one who kills a king **2** [prob. fr. (assumed) NL *regicidium*, fr. L *reg-, rex* + *-cidium* -cide] : the killing of a king

re·gime *also* **ré·gime** \rā-ˈzhēm, ri- *also* ri-ˈjēm\ *n* [F *régime*, fr. L *regimin-, regimen*] (1776) **1 a** : REGIMEN 1 **b** : a regular pattern of occurrence or action (as of seasonal rainfall) **c** : the characteristic behavior or orderly procedure of a natural phenomenon or process **2 a** : mode of rule or management **b** : a form of government ⟨a socialist ~⟩ **c** : a government in power ⟨predicted that the new ~ would fall⟩ **d** : a period of rule

reg·i·men \ˈrej-ə-mən *also* ˈrezh-ə-\ *n* [ME, fr. L *regimin-, regimen* rule, fr. *regere* to rule] (15c) **1 a** : a systematic plan (as of diet, therapy, or medication) esp. when designed to improve and maintain the health of a patient **b** : a regular course of strenuous training ⟨the daily ~ of a top ballet dancer⟩ **2** : GOVERNMENT, RULE **3** : REGIME 1c

[1]reg·i·ment \ˈrej-(ə-)mənt\ *n* [ME, fr. MF, fr. LL *regimentum*, fr. L *regere*] (14c) **1** : governmental rule **2** : a military unit consisting usu. of a number of battalions

[2]reg·i·ment \ˈrej-ə-ˌment\ *vt* (1617) **1** : to form into or assign to a regiment **2 a** : to organize rigidly esp. for the sake of regulation or control ⟨~ an entire country⟩ **b** : to subject to order or uniformity — **reg·i·men·ta·tion** \ˌrej-ə-mən-ˈtā-shən, -ˌmen-\ *n*

reg·i·men·tal \ˌrej-ə-ˈment-ᵊl\ *adj* (1659) **1** : of or relating to a regiment **2** : AUTHORITATIVE, DICTATORIAL

reg·i·men·tals \-ᵊlz\ *n pl* (1742) **1** : a regimental uniform **2** : military dress

re·gion \ˈrē-jən\ *n* [ME, fr. MF, fr. L *region-, regio*, fr. *regere* to rule] (14c) **1** : an administrative area, division, or district **2 a** : an indefinite area of the world or universe ⟨few unknown ~*s* left on earth⟩ **b** : a broad homogeneous geographical area ⟨the Appalachian ~⟩ **c (1)** : a major world area that supports a characteristic fauna **(2)** : an area characterized by the prevalence of one or more vegetational climax types **3 a** : any of the major subdivisions into which the body or one of its parts is divisible **b** : an indefinite area surrounding a specified body part ⟨a pain in the ~ of the heart⟩ **4** : a sphere of activity or interest : FIELD **5** : one of the zones into which the atmosphere is divided according to height or the sea according to depth **6** : an open, connected set together with none, some, or all of the points on its boundary ⟨a simple closed curve divides the plane into two ~*s*⟩

[1]re·gion·al \ˈrēj-nəl, -ən-ᵊl\ *adj* (1654) **1** : of, relating to, or characteristic of a region **2** : affecting a particular region : LOCALIZED

[2]regional *n* (1946) : something (as a branch of an organization or an edition of a magazine) that serves a region

re·gion·al·ism \ˈrēj-nəl-ˌiz-əm, -ən-ᵊl-\ *n* (1881) **1 a** : consciousness of and loyalty to a distinct region with a homogeneous population **b** : development of a political or social system based on one or more such areas **2** : emphasis on regional locale and characteristics in art or

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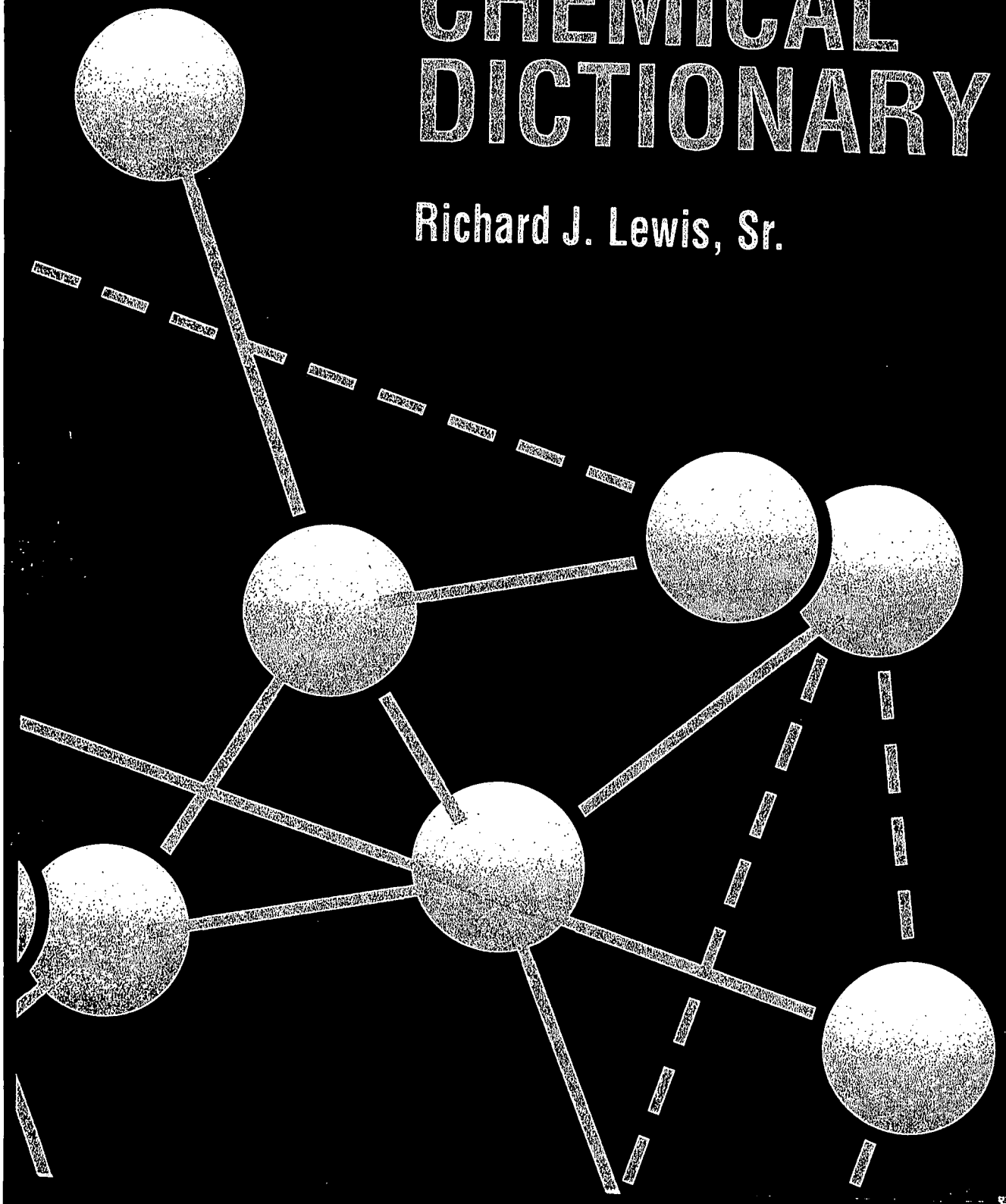
Hawley's CONDENSED CHEMICAL DICTIONARY

Twelfth Edition

Richard J. Lewis, Sr.



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The suspension is placed in a transparent container located in a solar concentrator.

carbon-black oil. A heavy refinery fraction similar to fuel oil, used as a feedstock for furnace black.

carbon, combined. A metallurgical term for carbon which has combined chemically with iron to form cementite, as distinct from graphitic carbon in iron or steel.
See also ferrite.

carbon cycle. (1) The progress of carbon from air (carbon dioxide) to plants by photosynthesis (sugar and starches), then through the metabolism of animals to decomposition products which ultimately return it to the atmosphere in the form of carbon dioxide. (2) One of the processes by which the sun and other self-luminous astronomical bodies are thought to derive their energy. The net process is the combination (fusion) of four hydrogen atoms to form helium. The carbon cycle involves successive additions of hydrogen atoms, followed by β decay, to an initial carbon-12 atom until a final step is reached in which the new nucleus breaks down to a helium atom and regenerated carbon-12. The carbon thus functions as a catalyst for the process. At the temperatures prevailing in the sun, all atoms are stripped of their electrons and the reaction is between the nuclei of the atoms (thermonuclear reaction). Symbolically the set of reactions is written
$^{12}C + {}^{1}H \rightarrow {}^{13}N$, $^{13}N \rightarrow {}^{13}C + e$;
$^{13}C + {}^{1}H \rightarrow {}^{14}N$, $^{14}N + {}^{1}H \rightarrow {}^{15}O$.
$^{15}O \rightarrow {}^{15}N + e$, $^{15}N \rightarrow {}^{12}C + {}^{4}He$.
See also fusion.

carbon dating. Radiocarbon dating is a method of determining quite accurately the age of a carbon-bearing material derived from living plants or animals within the last 70,000 years. It is based on determining the ratio of carbon-14 in the material to that in a modern reference sample by measuring the radioactivity of the carbon-14 in the material. Since the half-life of carbon-14 is 5730 30 years and the living precursor utilized carbon dioxide from the atmosphere or some other part of the earth's dynamic carbon reservoir, a process that ceased when the original plant or animal died, the amount of carbon-14 now present gives directly the age of the material. The carbon-14 in the reservoir is constantly being replaced by the sequence $^{14}N \rightarrow {}^{14}C + O \rightarrow {}^{14}CO_2$. This has maintained the ratio of carbon isomers constant during the ages; but burning of fossil fuels since the Industrial Revolution has lowered somewhat the fraction of carbon-14 in the atmosphere during the last few centuries, an effect that does not affect measurements on older objects. The sample to be tested must be carefully prepared to prevent contamination by younger carbon.
The radiocarbon technique was discovered by Willard F. Libby (1908–1980; Nobel prize, 1960), and has been applied with great success in the fields of archeology, geology, geochemistry, and geophysics. Its accuracy has been checked and verified by use of tree-ring counts (dendrochronology) and with the known ages of objects from ancient cultures, such as Egyptian and Chinese. The former shows that for the 2400–6000 year age of bristlecone-pine tree-rings, 5,200 ^{14}C years equal 6,000 calendar years.

carbon dichloride. See perchloroethylene.

carbon dioxide. CAS: 124-38-9. CO_2.
18th highest-volume chemical produced in the U.S. (1991).
Properties: (1) Gas: colorless, odorless, d 1.97 g/L (0C, 1 atm); d 1.53 (air = 1.00); (2) liquid: volatile, colorless, odorless, d 1.101 (−37C), sp volume 8.76 cu ft/lb (70F); (3) solid (dry ice): white, snow-like flakes or cubes; d 1.56 (−79C); mp −78.5C (sublimes). All forms are non-combustible. Miscible with water (1.7 volumes per volume at 0C and 0.76 volume per volume at 25C and 760 mm Hg partial pressure of CO_2). Also miscible with hydrocarbons and most organic liquids. An asphyxiant gas in concentrations of 10% or more; low concentrations (1–3%) increase lung ventilation and are used admixed with oxygen in resuscitation equipment.
Derivation: (1) Gas: for industrial use, carbon dioxide is recovered from synthesis gas in ammonia production, from substitute-natural-gas production, from cracking of hydrocarbons, and from natural springs or wells. For laboratory purposes it is obtained by the action of an acid on a carbonate. It is also a by-product of the fermentation of carbohydrates and an end product of combustion and respiration. Air contains 0.033% of carbon dioxide (see greenhouse effect). (2) Liquid: by compressing and cooling the gas to approximately −37C. (3) Solid (dry ice): by expanding the liquid to vapor and snow in presses that compact the product into blocks. The vapor is recycled.
Grade: Technical, USP, commercial and welding, 99.5%, bone dry (99.95%).
Hazard: Solid damaging to skin and tissue; keep away from mouth and eyes. TLV (gas): 5000 ppm in air.
Use: Refrigeration, carbonated beverages, aerosol propellant, chemical intermediate (carbonates, synthetic fibers, p-xylene, etc.), low-temperature testing, fire extinguishing, inert atmospheres, municipal water treatment, medicine, enrichment of air in greenhouses, fracturing and acidizing of oil wells, mining (Cardox

dry chemical. A mixture of inorganic substances containing sodium bicarbonate (or frequently potassium bicarbonate) with small percentages of added ingredients to render it free-flowing and water repellent.
Use: Fire extinguisher on fires in electric equipment, oils, greases, gasoline, paints, and flammable gases.

dry deposition. Deposition of materials from the atmosphere without the aid of rain or snow, e.g., particulates in the range of 2.5 microns as well as pollutant gases (SO_2, NO_2).
See also acid precipitation.

dryer. Any of numerous types of equipment used in the chemical industries to remove water from a product during processing. Space does not permit description of even a few of the great variety and multiplicity of choices available. The major types include the following:

belt	fluid-bed	screw
centrifugal	freeze	spray
convection	pan	tubular
conveyor	rotary drum	tunnel
flash	rotary tray	truck tray
	rotary vacuum	vibrating

See also drying.

dry ice. See carbon dioxide.

drying. (1) Polymerization of the glycerides of unsaturated vegetable oils induced by exposure to air or oxygen. See drying oil, drier.
(2) Removal of 90–95% of the water from a material, usually by exposure to heat. Industrial drying is performed by both continuous and batch methods. The type of equipment and the temperatures used depend on the physical state of the material, i.e., whether liquid (solution or slurry), semiliquid (paste), solid units, or sheet. *Continuous drying:* The rotating-drum dryer is used for flaked or powdered products (soap flakes); a heated metal drum revolves slowly in contact with a solution of the material, the dry product being removed with a doctor knife. In paper manufacturing, drying is performed by a battery of staggered steam-heated revolving drums located at the dry end of the fourdrinier machine, the paper passing around the drums at high speed; the moisture content is thus reduced from 60% to about 5%. In spray drying, milk, egg-white, and other liquid food products are passed through an atomizing device into a stream of hot air. In tunnel drying, the product travels on a conveyor belt through a heated chamber of considerable length. *Batch drying:* Steam-jacketed pans are used if the material is in paste or slurry form, or in removable trays placed in an oven, if in solid units (fruits, vegetables, meats, etc.). The revolving-tube dryer, used for granular solids and coarse powders, is a long, horizontal cylinder in which a current of warm air runs counter to the movement of the material. Freeze-drying is a specialized technique utilizing high vacuum and low temperatures.
See also dehydration, evaporation, freeze-drying.

drying oil. An organic liquid which, when applied as a thin film, readily absorbs oxygen from the air and polymerizes to form a relatively tough, elastic film. The oxidation is catalyzed by such metals as cobalt and manganese.
See drier.
Drying oils are usually natural products such as linseed, tung, perilla, soybean, fish, and dehydrated castor oils, but are also prepared by combination of natural oils or their fatty acids with various synthetic resins. The drying ability is due to the presence of unsaturated fatty acids, especially linoleic and linolenic, usually in the form of glycerides. The degree of unsaturation of an oil, and hence its drying ability, is expressed by its iodine number. The drying oils have the greatest capacity for iodine, and the nondrying oils the least.

"Dryspersion" [*Allied-Signal*]. TM for dry dispersion of rubber compounding chemicals in powder form. Deagglomerated and treated with non-staining oil.
Use: Rubber compounding.

DSC. See differential scanning calorimetry.

DSMA. (disodium methanearsonate).
CAS: 144-21-8.
Use: Herbicide.

DSP. Abbreviation for disodium phosphate.
See sodium phosphate, dibasic.

D-stoff See phosgene

DTA. See differential thermal analysis.

DTBP. Abbreviation for di-tert-butyl peroxide.

DTDP. Abbreviation for ditridecyl phthalate.

"Duclean" [*Du Pont*]. TM for acids containing pickling inhibitors.
Use: Pickling iron and steel. No. 1: sulfuric acid, 60 degrees Bé, d 1.706, fp −10.8C. No. 2: hydrochloric acid technical, d 1.142, fp 40C.
Hazard: Corrosive liquids.

Duff reaction. The ortho-formylation of phenols or para-formylation of aromatic amines